Use of Natural Coagulants to Remove Turbidity from water

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***Abstract*- Turbidity causes large scale problrm in water treatment in which turbidity removal is dependent on proper coagulation /flocculation stazge. Therefore present study,experiments were conducted in lab to remove the turbidity from water by using natural coagulants like banana pith and okra seeds by using synthetic turbid water. As we know that natural coagulants are used in less developed communities. Turbidity causes large scale problem in water treatment in which turbidity removal is dependent on proper coagulation/flocculation stage. In the present study, experiments were conducted in lab to find out the effect of size variation of natural coagulants banana pith and Okara to remove the turbidity by using synthetic turbid water. As we know natural coagulants are in general, used in less developed communities as they are economical when compared with chemical coagulants. These natural coagulants are easily available in India and it is easily biodegradable. By using grinder dry banana pith and Okara can be easily crushed in different sizes as 600, 300 & 75 µm particles. Jar test experiments are carried out for high (380NTU), Medium(150NTU) and low(30NTU) turbid water samples. Size variation to remove turbidity for varying pH was also studied with respect to different settling time intervals. Natural coagulant shows better results for high turbid water. Maximum turbidity removal efficiency for Banana pith ,Okara are 94.2%, 92.8 and 91.5 respectively for small (75 µm) particle size. In order to reduce the turbidity, means for optimization main affecting parameters are coagulant dose, initial turbidity, pH & settling time. To avoid the ill effects & complexity, these natural coagulants are used as coagulant aid with alum. Use of natural coagulant to remove turbidity plays a vital role in sustainable environmental technology as they are renewable resources.**

Banana pith was obtained from market from harvested banana plantain. The pith was cleaned and rinsed with distilled water. Cut into small pieces and dried in an oven at 60degree C for 6 h. The dried pieces were ground into a powder and and sieve were used for tests. Okra commonly known as lady finger is one of the important vegetable crop grown in tropical and subtropical region of the country. The oil present in the okra seeds is extracted first and then utilized for the treatment of waste water treatment.

***Index Terms*- Turbidity,banana pith, Okra, Synthetic turbid water, Coagulation, Alum, pH.**

1. INTRODUCTION

Turbidity is a characteristic of suspended matter in water, which offers obstruction to the passage if light through it. The greater the obstruction offered the greater is the turbidity of water. The turbidity depends upon the fineness and concentration of particles present in water. Turbidity removal is one of the important steps in water treatment process and generally is achieved by coagulation – floculation – sedimentation process[2]. Common coagulants like alum and salt has been widely used in conventional of water treatment processes[1]. Recently many have pointed serious drawbacks of using thes coagulants. Many researchers have worked on natural coagulation produced and extracted from plants, and animals and microorganisms. Banana pith and okra seed powder are tropical multipurpose tree which grows in india,south Africa, America.[1] The traditional use of these plant based coagulant for domestic household water treatment is limited to rural areas ,where surface water is used for drinking purposes. It has been reported that banana pith has coagulation and antimicrobial properties.

Okra commonly known as lady finger is one of the important vegetable crop grown in tropical and subtropical region of the country. The oil present in the okra seeds is extracted first and then utilized for

the treatment of waste water treatment. Studies represent that the volume of Gumbo mucilage decides the pH which changes the turbidity of the water[5].

Objectives

- To study the effect of coagulant on turbidity removal efficiency.
- To study effect of pH on turbidity removal.
- To study settling time effect on residual turbidity.
- To optimize of natural coagulant as coagulant Aid in conjunction with alum.

2. METHODOLOGY

2.1 A) *Material and Methods:*

The basic material used in the study are Natural coagulants such as Banana Pith , okra seed powder in different sizes.

a) Banana pith was obtained from market from harvested banana plantain. The pith was cleaned and rinsed with distilled water. Cut into small pieces and dried in an oven at 60degree C for 6 h. The dried pieces were ground into a powder and and sieve were used for tests.[1]

b) Preparation of synthetic water and coagulant powder is eludicated below.

c)

Fig. 1 Banan Particals

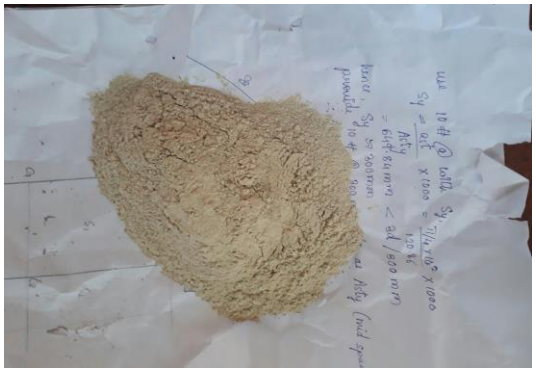


Fig. 2 Banana pith

B) Preparation of synthetic turbid water

Locally available natural clay was used to prepare synthetic turbid water by soaking the clay for 24 hours in tap water and then blending it for 10 min. About 30 gm of the clay material is added to 1 lit of tap water .The suspention was washed through a 75 micron sieve . This was kept as a stock suspension for preparation of different turbidities such as low, medium, high . A portion of stock suspention was diluted with tap water and after 30 min of settling in a container, the supernatant was carefully decanted turbiditis of 30NTU(low), 150NTU(medium), 380NTU(high) were obtained by diluting it.

Stock solution of natural Coagulants

The grains of powder were maintained approximate size less than 600µm to achieve solublization of active ingredients in the seeds. Mature seeds of okra were used in the study.after dry sun external shell were removed and seeds kernel were obtained .using grinder fine powder achieved from seeds. Disstilled water were added to powder to make 1% suspension to it.The suspension was vigoursly sheken for 45 min using a magnetic stirrer to promote water extraction of water coagulants proteins and this was then passed through filter paper. (Whatman no.42,125mm dia). The filter proteins were kept refrigerated to prevent any ageing effects (such as change in pH ,viscosity and coagulation activity). Solutions were shekan vigourously before.[4]

C)Jar Test Operation.

Jar test is most widely used experimental methods for coagulation – flocculation. A flocculator jar test apparatus is used in experiments to coagulate sample of synthetic turbid water using some coagulants.It is carried out as batch test ,accommodating a series of six beakers together with six spindle steel paddles. Before operating the jar test ,the sample is mixed homogenously. Coagulants with varying concentration are added in beaker .The whole procedure in jar test is conducted in different rotating speed . Coagulation and flocculation tests were carried out on water sample from tab water using conventional jar test apparatus at room temperature. The pH of water was varied using 1M HCL and NaOH. River water 500 mL was transferred to 1 L jars and placed in jar test apparatus . Banana pith coagulant was added at dosages of 0.1-1 kg/m^3. The

mixture was subjected to 3 min of rapid mixing at 180 rpm followed by 20 min of mixing at 10 rpm and 30 min of settling. During settling samples were withdrawn with pipette from 2 cm depth at 5 min intervals for 30 min . The turbidity of samples was measured using turbidity meter to study peri-kinetic flocculation. The fig shows the set up for jar test apparatus.[1]

Fig. 3 Experimental Setup.

2.2 Phases of experiment.

Batch Coagulation –Sedimentation Test

Batch coagulation – Sedimentation test were carried to determine the coagulation properties of the natural coagulants. One beaker was used as control and in other beakers varying dosages of coagulants were added.

Jar test were conducted on 500 mL synthetic turbid water samples of low (30) ,medium(150)and high (380) turbidity. Following the addition of coagulants were added in different sizes, the samples were subjected to rapid mixing at 100 to 180 rpm for 3 min . The sample for surface of each beaker,and residual turbidity was measured .

Effect of varying pH

A 50 mL of 0.1 M KNO3 solution was transferd into a series of 100 mL conical flask .The initial pH value of the solution were adjusted from 2 to 10 by the addition of 0.1 N of HNO3. 1.5 g of banana pith biomass was added to each flask and the flask capped immediately. That flask were kept in const temperature water bath shaker and shaken for 24 h after which the pH was measured.

Optimization of Natural coagulant as coagulant aid in conjunction with alum

The effect of combined dose of natural coagulant and alum on removal of turbidity that is natural coagulants as a coagulant aid also studied . In order to decresase the residual Al+3 concentration in treated water ,and possible adverse effect of aluminum in drinking water on human health , natural coagulants as a coagulant aid in conjunction with alum were used. Also in this expt. Approximately 1/2th of optimum dose of alum and varying doasges of natural coagulants were applied to the synthetic turbid water (low, medium and high) and combined optimum dosages were applied to various natural coagulants.[9]

Effect of settling time

The settling is used to describe all type of particles falling through a liquid under force of gravity and settling, in which the particles or colloids are suspended by hydrodynamic forces high particles conc.individual particles behavior is influenced or hinderd by presence of other particles and flow characteristic of bulk suspension can be affected. The increased particle concentration ,the free area between particles is reduced., causing greater inter particle fluid velocities and alteration of flow patterns around particles[8]. The avg. settling velocity of particles in a conc. Suspension is generally less then that of discrete particles of similar size.Colloids always require coagulation to achieve and effective size and settling rate .Larger particles which are not truly colloidal & would settle ,if given enough time to form larger ,faster settling floc[3]. When insufficient settling time is available in a treatment plant to remove suspended solids, coagulation and flocculation may cause to grow in size and settle rapidly enough to overcome the physical limitation of plant design. In these experiment effects of settling time on residual turbidity was studied by extending the settling time. Results were recorded in tabular form for all coagulants.[2]

3. RESULTS AND DISCUSSIONS

Experiments are carried out in the laboratory on okra seed powder , banana pith powder. All coagulation experiments are carried out using synthetic turbid water and turbidity ranges are maintained as Low Turbidity[30],Medium Turbidity:[150] and [380]High Turbidity [380] and results obtained are tabulated as follows.

3.1 Batch Coagulation Study [Banana pith]

Table 4.1: For Batch Coagulation [Banana pith]

pH	Particle size of coagulant	Sample dose mg/lit	Initial turbidity [NTU]	Residual turbidity	% turbidity removal
7-7.5	600	0	30	27	11.46
		20		26	45.69
		40		24	53.52
		60		18	56.75
		80		11	61.89
		100		9	61.34
		0	150	128	16.92
		20		70	58.89
		40		58	64.77
		60		49	69.22
		80		45	74.10
		100		46	73.61
		0	380	335	17.46
		20		170	68.22
		40		120	71.49
		60		102	78.79
		80		80	82.74
		100		75	82.68
	300	0	30	28	13.55
		20		15	48.09
		40		13	61.43
		60		12	64.55
		80		12	67.22
		100		09	66.96
		0	150	130	21.96
		20		60	65.08
		40		52	70.25
		60		41	74.14
		80		28	78.90
		100		25	78.12
		0	380	310	19.5
		20		140	71.7
		40		60	74.0
		60		63	83.0
		80		52	85.4
		100		42	85.0
	75	0	30	28	8.46
		20		12	58.98
		40		11	61.21
		60		09	68.62
		80		08	69.95
		100		08	69.58
		0	150	120	21.40
		20		45	70.35
		40		39	73.86
		60		36	76.34
		80		27	82.08
		100		2	81.78
		0	380	309	20.0
		20		122	68.3
		40		59	84.7
		60		53	86.3
		80		43	88.8
		100		42	87.0

From table 5.1, it is seen that, the coagulant with larger particle size [600 µm] for low turbidity [30 NTU] have less [61.89] % turbidity removal efficiency whereas for smaller [75 µm] it gives [69.95] ,Also for high turbidity [380 NTU] larger size particle [600 µm] shows % turbidity removal efficiency [82.74] and for [75 µm] it gives [88.8]

3.2 Effect of pH on Removal Efficiency

Table 3.2: Effect of pH on Removal Efficiency

Coagulant	Coagulant Dose mg/l	Coagu-lantparti-cle size (µm)	pH	InitialTurbidity NTU	Res-Idual Turbidity , NTU	% Turbidity Removal Efficiency
Banana pith	40(Const.)	600	4	150(med)	60	60
			6		57	62
			9		59	61
		300	4		50	66
			6		49	67
			9		50	67
		75	4		46	69
			6		44	71
			9		45	70

From table 5.3, it is seen that, for constant Banana pith dose [40 mg/lit] and medium turbidity [150 NTU], as the pH varies 4, 6, 9, it gives maximum % turbidity removal efficiency [71] for smaller [75 µm] size particle at pH 6.

II) For batch Coagulation (Okra seed powder)

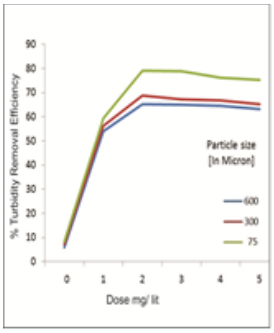
Table 3.3 For Batch Coagulation (okra seed powder)

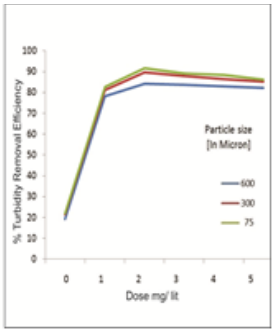
pH	Particle size of coagulants	Sample dose Mg/lit	Initial Turbidity	Residual Turbidity	%Turbidity Removal
7-7.5	600	0	30 (low)	27	10
		20		26	13.33
		40		24	20
		60		22	26.66
		80		18	40
		100		21	30
		0	150 (medium)	128	14.66
		20		70	53.33
		40		58	61.33
		60		49	67.33
		80		45	70
		100		52	65.33
		0	380 (high)	340	10.52
		20		170	55.26
		40		120	68.42
		60		102	73.12

		80		80	78.97
		100		89	76.57
	150	0	30 (low)	28	6.66
		20		15	50
		40		13	56.66
		60		12	60
		80		12	63.33
		100		9	70
		0	150 (medium)	130	13.33
		20		60	60
		40		52	65.33
		60		41	72.66
		80		28	81.33
		100		25	83.33
		0	380 (high)	310	18.42
		20		140	63.15
		40		60	84.21
		60		63	83.42
		80		52	86.31
		100		42	88.94

From table, it is seen that , the coagulants with larger particles size (600µm) for low turbidity (30 NTU) have less (70)% turbidity removal efficiency whereas for smaller (150µm) it gives (83.33)

Also for high turbidity (380 NTU) larger size (600µm) particle shows % turbidity removal efficiency (88.94).

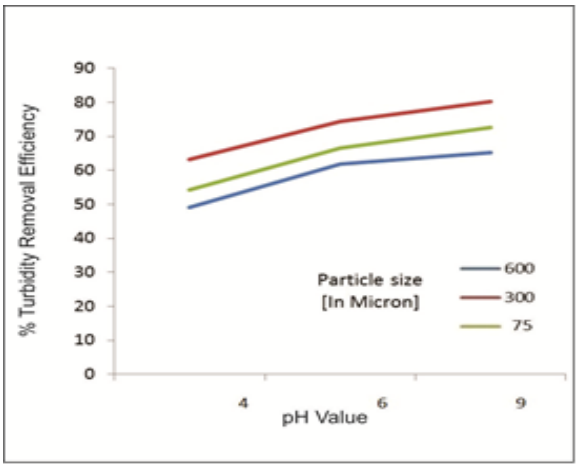




Dose Vs Removal efficiency Dose Vs Removal efficiency

Coagulant	Coagulant Dose mg/l	Coagulant particle size (µm)	pH	Initial Turbidity NTU	Residual Turbidity , NTU	% Turbidity Removal Efficiency
Okara	2 (Const.)	600	4	150 (medium)	77	48.66
			6		54	64
			9		70	53.33
		300	4		58	61.33
			6		39	74
			9		51	66
		75	4		53	64.66
			6		30	80
			9		41	72.66

From table 3.4, it is seen that, for constant dose of Okra [2 mg/lit] and medium turbidity [150 NTU], as the pH varies 4, 6, 9, it gives maximum % turbidity removal efficiency [80.2] for smaller [75 µm] size particle at pH 6



pH Vs Removal efficiency

3.4 Effect of Settling Time in Minutes on residual Turbidity.

Table 3.5 : Effect of Settling Time in Minutes on Residual Turbidity

pH	Initial Turbidity NTU	Name of Coagulant	Coagulant Dosages mg/l	Size of Coagulant (µm)	Settling Time in Minutes / Residual Turbidity , NTU				
					30	60	90	120	150
7-7.5	150	Banana pith	80	600	39.62	38.22	37.01	35.70	34.00
				300	32.28	31.10	29.55	28.12	27.20
				75	27.41	26.12	25.88	24.00	23.34
		Okra	4	600	32.13	31.42	30.18	28.54	26.43
				300	27.69	25.89	24.91	23.05	22.95
				75	23.26	22.78	21.54	16.21	15.07

From table it is seen that, for medium turbidity [150 NTU] as we increases the settling time, residual turbidity goes on decreasing at certain time limit.

4. CONCLUSIONS

Banana pith and Okra seed powder contain material that can act as effective natural coagulant and different conclusions of obtained from experiments are as follows,

1. Natural coagulant presents in seeds of Banana pith shows that turbidity removal efficiency is more for neutral pH, whereas acidic and basic pH values have less turbidity removal efficiency. The evaluation of herbs as a coagulant has been used as to reduce the level of turbidity in water treatment. The following are the some of the conclusions drawn from this work.[1]
2. When natural coagulants as banana pith, and Okara are used in different sizes as 600, 300 & 75 micron particle size then fine particle size

means 75 micron shows maximum turbidity removal efficiency. As dose of natural coagulant is increases removal efficiency is also increases.

3. The results of coagulant aid study found to be 3.6,4.7 and 3.8 NTU for banana pith, Okara respectively , which are within the permissible limit as per BIS standard.
4. As the settling time increases the residual turbidity get decreased at certain time limit above that period no much variation was found for constant coagulant dose.
5. The mathematical model derived from experiments is significant. The ANOVA analysis performed assures the reliability of the models indicating a good significance of the factors.[1]

REFERENCES

[1] Antov., Sumath, S., Hameed, B., 2006. Coagulation of residue oil mill effluent by chitosan, alum and PAC. Chem. Eng. J., 99–105.
[2] Aparecido, N., Fernado, R., Claudinata, A., Diego, R., 2015. Assessment of the banana pseudoatem as a low-cost biosorbent for the removal of reactive blue 5G dye.Environ. Technol. 36 (22), 2892–2902.
[3] Gray, J.R., Gylsson, G.D., Turcios, L.M., Schwarz, G.E., 2000. Comparability of suspended-sediment concentration and total suspended solids data. In: USGSWater-Resources Investigations Report 00-4191. US Geological Survey, Reston,VA.
[4] Holthof, H., Schmitt, A., Fernandez-Barbero, M., Cabrerizo-Vilehez, P.,Schurtenberger, P., 1997. Measurement of absolute rate constants for colloidal particles: comparison of single multiparticle light scattering techniques. J.Colloids Interface Sci. 192, 463–470.
[5] Renault, F., Sancey, B., Charles, J., Morin-crini, N., Badot, P., Winterton, P., 2009.Chitosan flocculation of cardboard-mill secondary biological wastewater.Chem. Eng. J. 155, 775–783.
[6] Jahn, S., 2001. A drinking water from Chinese river: challenges of clarification. J.Water SRT-Aqua. 50, 15–27.
[7] Radoiu, M., Martin, D., Calinescu, I., Iovu, H., 2004. Preparation of polyelectrolytesfor wastewater treatement. J. Hazard. Mater. 106, 27–37.
[8] Chaudhuri, M., Babu, R., 2005. Home water treatment by direct filtration withnatiral coagulant. J. Water Health 3, 27–30.
[9] M.A. Aboulhassan, S. Soubi, A. Yaacoubi, Baudu, J. Hazard. Mater. 138 (2006) 40.
[10] Rico, T., Santos, F., Reis, E., 2010. Treatment of Tannery Wastewater Using Seeds ofMoringa Oleifera, vol. 4. Agro Magazine Environment, pp. 96–110.